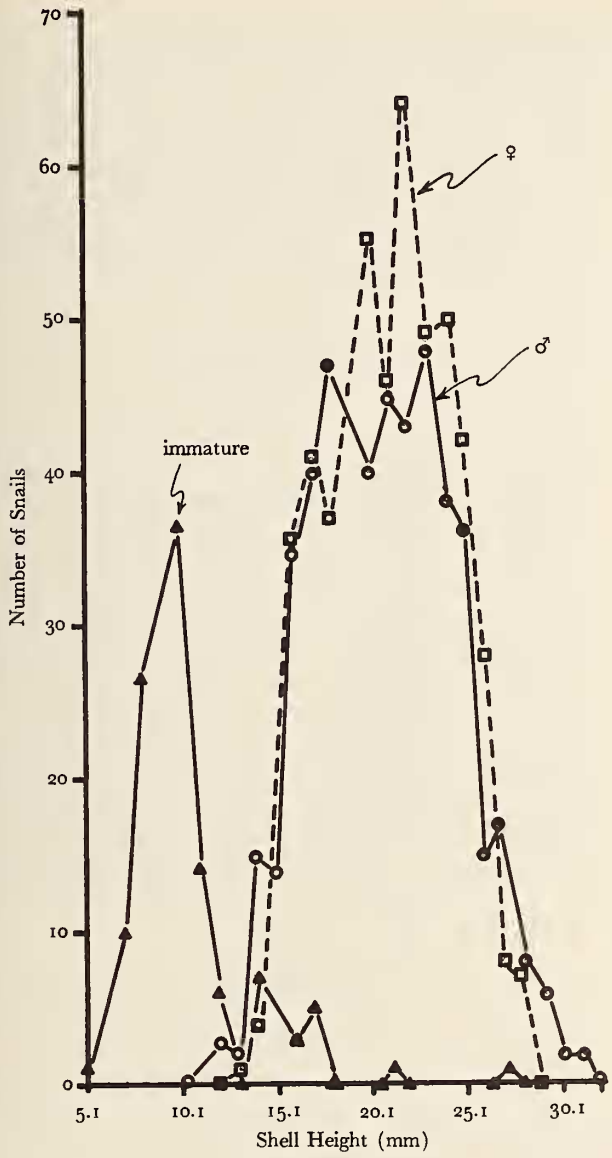

expected 1 : 1 sex ratio (Table 1). A collection of 1175 drills made in May, 1974, from the Noank population indicated balanced sex ratios over all size classes. But males did appear to attain larger maximum size than females. In addition, gonads of snails less than about 12mm in height were not developed and therefore could not be sexed by this method (Figure 2).

Since initial observations suggested that the relative penis size of females varied among the populations examined, samples of mature snails (male and female) from each population were taken, and their penises as well as shell heights measured. Low correlation coefficients ($|r| = 0.03 - 0.29$) of relative penis size to shell height indicated that the relative penis size is independent of shell height. For statistical analyses Student t tests were computed not assuming equality of variance (Brownlee, 1965).

Intrapopulation comparisons between sexes revealed, as expected, very highly significant differences ($P < 0.001$) in relative penis size in all Connecticut populations (Figure 3). While relative penis sizes of males were not significantly different at the 5% level among these populations, highly significant differences ($P < 0.01$, at least) were found in all comparisons with females (Figure 3).

To determine whether there were seasonal effects upon relative penis size, Ram Island and Noank population samples were isolated in trays of running seawater at ambient temperatures from October, 1973, through Jan-

(← adjacent column)

Figure 2

Sex and shell-height frequency distributions of *Urosalpinx cinerea* collected from Noank, Connecticut, May 1974.

□ = females ($\bar{X} = 21.5 \pm 3.3$mm)
○ = males ($\bar{X} = 21.5 \pm 3.8$mm)
▲ = primarily immature individuals

Table 1

Chi-square (χ^2) analyses of sex ratios for several seasonal samples of *Urosalpinx cinerea* from Noank, Connecticut. Immature and questionable individuals are eliminated in the calculations; a 1:1 sex ratio is assumed.

Date Collected	Females	Males	Immatures and Unknown	$\chi^2(1)$	P
July, 1973	65	75	–	0.714	>0.30
October, 1973	220	234	–	0.432	>0.50
April, 1974	186	206	49	1.02	>0.30
May, 1974	524	499	152	0.611	>0.40
Total	995	1014	201	0.181	>0.60

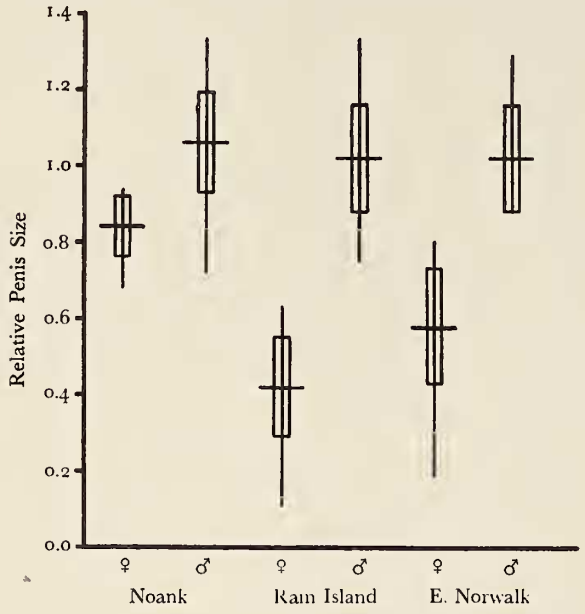

Figure 3

Variation in relative penis size among several Connecticut populations of *Urosalpinx cinerea*. The means (horizontal lines) are expressed as ± one standard deviation (bar); the vertical line denotes the range

uary, 1974. The snails were maintained on a diet of *Mytilus edulis* for the duration. Samples were taken at the beginning and end of this period. Seasonal comparisons within sexes and populations indicated that mean penis size showed a comparable decrease in all cases, and the decrease was significant in 3 out of 4 comparisons (Table 2). However, the female/male relative penis size ratios did not decrease over this period in these 2 populations (0.79 and 0.40 respectively for the 2 Noank and Ram Island seasonal samples).

DISCUSSION

Female *Urosalpinx cinerea* in all Connecticut populations examined exhibited penises; in the Noank population, male and female penises are similar in size. The live-sexing technique of Hargis (1957) is thus inapplicable. Carriker & Van Zandt (1972) have used the presence or absence of the ventral pedal gland, with which the female forms the egg capsule, as a sexing criterion for *U. cinerea follyensis*. But the ventral pedal gland is difficult to differentiate with the smaller Connecticut oyster drills, and this technique cannot be used conveniently.

In studies which do not necessitate preserving specimens alive or the shell intact, the microscopical examination of gonadal smears or the observation of gonadal texture as herein proposed provide reliable means of sex determination. Where the live-sexing technique is desirable involving populations which exhibit penises in the females, the validity of the technique should be confirmed by either method mentioned above.

No evidence from sex ratios or size-frequency analyses suggests any sex reversal in the Noank population. There

Table 2

Seasonal variation in relative penis size of two *Urosalpinx cinerea* populations from Connecticut. Asterisk indicates significant seasonal change in relative penis size.

Locality and Sex Comparison	N	$\bar{x} \pm$ S.D.	Range	t(d.f.)	P
Noank females (10/73)	24	0.84 ± .07	0.68- .94	2.40 (43)	< 0.05*
Noank females (1/74)	25	0.78 ± .10	0.55- .93		
Noank males (10/73)	26	1.06 ± .13	0.72-1.33	1.88 (44)	0.05
Noank males (1/74)	25	1.00 ± .09	0.84-1.20		
Ram Island females (10/73)	34	0.42 ± .13	0.11- .63	2.34 (61)	< 0.05*
Ram Island females (1/74)	31	0.35 ± .13	0.00- .59		
Ram Island males (10/73)	18	1.02 ± .14	0.75-1.33	3.58 (27)	< 0.002*
Ram Island males (1/74)	19	0.89 ± .08	0.80-1.08		

is also nothing unusual in the sexual life history of this gastropod, which exhibits continuous gonadal development throughout the year (Manzi *et al.*, 1971). A sexual dimorphism in size has been reported for several populations of this species (Stauber *in* Carriker, 1955; Hargis & MacKenzie, 1961; Griffith & Castagna, 1962) with the female reaching a larger maximum and mean size than the male. Such a relationship is not apparent in the Connecticut population of the present study. In fact, the males may attain a larger maximum size than the females in the Noank population. This discrepancy may be due to differences in our respective sampling methods, since animals in these earlier studies – collected by oyster drill traps – were predominantly females, suggesting sampling bias attributable to the behavior of females during oviposition periods. Females tend to be attracted to raised solid objects on which to deposit their egg capsules, and traps loaded with oyster shells provide the ideal substrate. The sampling procedure employed in the present study avoids this bias.

The relative penis size of the female is so variable among Connecticut populations that this could conceivably be used in characterizing *Urosalpinx cinerea* populations. Whether this variability has a genetic basis or is environmentally induced has yet to be determined. The comparatively uniform decrease in relative penis size of both sexes of Noank and Ram Island populations in the winter may be due to seasonal atrophy associated with cessation of feeding and depletion of reserves during winter hibernation.

SUMMARY

An alternative method for rapid sexing of *Urosalpinx cinerea*, based on gonadal texture, is described. The variability in relative penis size of female snails among Connecticut populations is also presented. Seasonal examinations of gonadal texture and shell height-frequency distributions show that neither deviations from one-to-one sex ratio, sex reversal, nor marked sexual size dimorphism is apparent in Connecticut populations.

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